

amateur radio basic advanced exam worked examples

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Amateur Radio Basic and Advanced Exam Worked Examples: A Complete Guide

For anyone interested in the world of ham radio, passing the FCC's amateur radio licensing exams is the first step toward unlocking a hobby that blends science, technology, and community service. Whether you're aiming for the Technician (basic) license or the more advanced General and Extra classes, the exams can feel daunting. That's where worked examples come in – they provide a clear, step by step approach to solving the type of questions you'll encounter on test day.

This article dives deep into the structure of the amateur radio exams, outlines the core topics, and presents a curated set of worked examples for both the basic and advanced levels. By the end, you'll have a solid study plan, a better understanding of what the examiners are looking for, and a collection of practice problems that will boost your confidence.

Understanding the Amateur Radio Licensing Structure

What is the FCC and the ARRL?

The Federal Communications Commission (FCC) is the U.S. regulatory body that oversees all radio communications. The American Radio Relay League (ARRL) is the national association that administers the amateur radio exams and provides study materials. Together, they set the standards for licensing, ensuring that operators possess the knowledge and ethical conduct required to use the radio spectrum responsibly.

Basic (Technician) Exam Overview

The Technician license is the entry level qualification, granting access to 2 meter and 70 centimeter bands, and a limited portion of the 10 meter band. The exam consists of 35 multiple choice questions, with a 70 percent passing threshold. Topics include:

- Radio fundamentals
- Regulations and operating procedures
- Basic electronics and circuitry
- Safety and licensing requirements

Advanced (General, Extra) Exam Overview

After earning the Technician license, operators can pursue the General license, which unlocks additional bands and frequencies. The Extra license is the highest class, granting full access to all amateur bands. The Advanced exams (General and Extra) each contain 50 multiple choice questions, requiring a 70 percent pass. They cover:

- Advanced radio theory
- Propagation, antennas, and RF design
- Complex electronics and digital modes
- Regulatory nuances and emergency communications

Key Topics Covered in the Basic Exam

Below is a concise summary of the most frequently tested areas on the Technician exam:

1. Frequency Bands and Allocation – Understanding where to operate and the purpose of each band.
2. Modulation Methods – AM, FM, SSB, CW, and digital modes.
3. Regulatory Rules – FCC Part 97, the ARRL's operating code, and licensing requirements.
4. Basic Electronics – Ohm's Law, series vs. parallel circuits, and component identification.
5. Safety Practices – Grounding, RF exposure limits, and equipment handling.

Key Topics Covered in the Advanced Exam

The General and Extra exams delve deeper into technical and regulatory subjects:

1. Propagation Phenomena – HF propagation, ionospheric layers, and tropospheric ducting.
2. Antenna Theory – Resonance, SWR, feedline loss, and antenna types.
3. RF Design and Safety – Matching networks, impedance, and power handling.
4. Digital Modes – FT8, FT4, JT65, and other narrowband modes.
5. Emergency Communications – CW procedures, net operations, and crisis protocols.

Why Worked Examples Matter

Benefits of Practicing Worked Examples

Worked examples are more than just practice problems; they are a learning tool that:

- Illustrates the reasoning process – Shows how to apply formulas and rules to real questions.
- Reinforces retention – Repeated exposure to problem structures improves recall.
- Builds confidence – Familiarity with question formats reduces test anxiety.
- Highlights common pitfalls – Spotting mistakes in sample solutions helps avoid them.

By integrating worked examples into your study routine, you'll transition from passive reading to active problem solving, which is essential for mastering the exam's breadth.

Sample Worked Examples for the Basic Exam

Worked Example 1: Frequency Allocation

Question: Which of the following frequencies is allocated for amateur use under the FCC Part 97?

1. 145.000 MHz
2. 146.520 MHz
3. 147.200 MHz
4. 148.000 MHz

Answer: 146.520 MHz (Option B)

Explanation: The 2 meter band spans 144–148 MHz. The specific allocation for amateur use is 146.520 MHz, designated as the 146.520–146.530 MHz segment for CW and data. The other frequencies either lie outside the amateur band or are reserved for other services.

Worked Example 2: Ohm's Law

Question: A resistor in a circuit draws 0.5 A from a 12 V supply. What is the resistance?

1. 2 :•
2. 24 :•

3. 6 Ω
4. 0.5 Ω

Answer: 24 Ω

Explanation: Ohm's Law: $V = IR$. Rearranging gives $R = V / I = 12 \text{ V} / 0.5 \text{ A} = 24 \text{ Ω}$

Worked Example 3: Modulation Identification

Question: A radio operator transmits a 10 kHz audio tone on a 7.100 MHz carrier. What modulation type is being used?

1. FM
2. AM
3. SSB
4. CW

Answer: AM (Option B)

Explanation: In AM, the carrier amplitude varies with the audio signal. The presence of a 10 kHz tone indicates amplitude modulation, not frequency or single sideband modulation.

Worked Example 4: Safety – RF Exposure

Question: An operator is working with a 2 meter transmitter outputting 100 W. According to FCC limits, what is the maximum permissible distance from the antenna for safe operation?

1. 10 meters
2. 30 meters
3. 50 meters
4. 100 meters

Answer: 30 meters (Option B)

Explanation: The FCC's RF exposure limits for 2 meter bands prescribe a minimum distance of 30 meters for a 100 W transmitter to keep exposure below 1 mW/cm². Staying beyond this boundary ensures compliance with safety regulations.

Worked Example 5: Bandplan – 70 cm Band

Question: Which frequency is part of the 70 cm amateur band allocated for CW and data?

1. 434.000 MHz
2. 435.000 MHz
3. 436.000 MHz
4. 437.000 MHz

Answer: 435.000 MHz (Option B)

Explanation: The 70 cm band ranges from 420–450 MHz. The 435.000–435.050 MHz segment is specifically reserved for CW and data transmissions. The other frequencies either fall outside the band or are reserved for other modes.

Sample Worked Examples for the Advanced Exam

Worked Example 1: Propagation – HF Skips

Question: A 14.250 MHz signal is transmitted from a station in the U.S. to a station in Europe. Which ionospheric layer is most likely responsible for the successful long haul communication?

1. F1
2. F2
3. E
4. D

Answer: F2 (Option B)

Explanation: The F2 layer is the uppermost ionospheric layer and provides the most reliable long haul HF propagation during the day. It reflects 14 MHz signals effectively, enabling trans Atlantic contacts.

Worked Example 2: Antenna – Resonance Frequency

Question: A half wave dipole for the 20 meter band (14–14.35 MHz) is designed with a total length of 10 meters. What is the resonant frequency of this dipole?

1. 7.00 MHz
2. 14.00 MHz
3. 21.00 MHz
4. 28.00 MHz

Answer: 14.00 MHz (Option B)

Explanation: A half wave dipole resonates at a frequency where its length equals $\lambda/2$. For a 10 meter dipole, $\lambda/2 = 20$ meters, giving $f = c / \lambda$; $3 \times 10^8 \text{ m/s} / 20 \text{ m} = 15 \text{ MHz}$. However, due to end effect and feedline considerations, the practical resonant frequency is slightly lower, around 14 MHz, matching the 20 meter band.

Worked Example 3: SWR and Matching

Question: An antenna system exhibits a standing wave ratio (SWR) of 2:1 at 7.150 MHz. What is the percentage of power reflected back to the transmitter?

1. 10%
2. 20%
3. 25%
4. 30%

Answer: 20% (Option B)

Explanation: Reflection coefficient $\rho_0 = (SWR - 1) / (SWR + 1) = (2 - 1) / (2 + 1) = 1/3$. Power reflected = $|\rho_0|^2 = (1/3)^2 = 0.111$, or 11.1%. However, many exam questions approximate

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